Menlo Park Notebook #40 [N-79-03-31]

This notebook covers the period March 1879-May 1880. The entries are by John W. Lawson and include notes on metal alloys made and tested and notes on experiments with pyrites. The label on the front cover is marked "Alloys and Ores." The book contains 288 numbered pages.

Blank pages not filmed: 28-47, 70-73, 78-99, 112-139, 142-163, 166-175, 178-179, 182-275.

No 40

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No 40

1

Alloys

March 31/79.

J. W. Lawson

Copper & Zinc

No 1. 90% Cu, 10% Zn

Melted Cu in crucible, added Zn in small pieces; stirred and reheated, then poured into mould –

No 2. 80% Cu, 20% Zn

Treated same as preceding

No 3 70% Cu, 30% Zn

Melted Cu in crucible, then added Zn; stirred, and reheated longer time than the preceding –

[ITEM FOUND IN BOOK]

Heat – or ~~ras~~ roast
Alum with $PbCO_3$
or $Pb(C_2H_3O)_2$

Use pot ~~or~~ alumina
or..

Copper	90	Zinc	10	1
"	80	"	20	2
"	70	"	30	3
"	60	"	40	4
"	50	"	50	5
"	40	"	60	6
"	30	"	70	7
"	20	"	80	8
"	10	"	90	9

Varying as above

~~Copper & Iron~~ No Good
" & Lead
" Not to be ~~Cadmium~~
~~" Antimony~~
" " Arsenic

Zinc & Iron
" " Lead
~~" " Cadmium~~
~~" " Antimony~~
" " Arsenic

Iron & Lead No Good
" Not to be ~~Cadmium~~
" " Antimony
" " Arsenic

~~Lead & Cadmium~~
~~" " Antimony~~
" " Arsenic

Cadmium & ~~Antimony~~
" Not to be " Arsenic

Antimony & Arsenic

No. 7 Note Cast over again – (Exceedingly brittle)

Melted Cu in crucible, added Zn, covered with powdered coke, reheated and cast. Coke seemed to prevent volatilization of Zn –

No. 9, Recast – Treated same as preceding.

No. 4 60 % Cu, 40 Zn

Melted Cu in crucible, then added Zn in small pieces, stirred well, and poured into mould without reheating in fire.

No. 5 50 % Cu, 50 % Zn

Melted Cu in crucible, etc.; then reheated; a great loss of Zn by volatilization

---

No 5.^{2} 50 % Cu, 50 % Zn

Melted Cu in crucible, added Zn, stirred well and poured in mould without reheating

o. 5½ $45\frac{5}{11}$% Cu, $54\frac{6}{11}$% Zn
% on Crusie's book wrong

Melted Cu in crucible, ect; poured into mould without reheating –

No. 6 40% Cu, 60% Zn

Treated same as preceding

No. 7 30% Cu, 70% Zn

Melted Cu in crucible, added Zn in small pieces, and reheated – Loss of Zn by volatilization – Recast, page 6

No. 8 20% Cu, 80% Zn

Treated same as preceding
(Average loss of Zn).

No. 9 1 (Great loss of Zn by volatilization)

10% Cu, 90% Zn

Treated same as preceding. Note, page 6

Copper & Iron

"As a rule iron may be alloyed with most metals; but its alloys, always difficult to effect, and in the majority of cases only with a small proportion of iron, have up to the present time resulted in very few applications to the arts."

Fesquet, page 98.

No. 2" Recast –

Melted Fe and Cu in separate crucibles, then pou Fe into Cu – Not full proportion of Fe, as por would not unite with Cu, but remained in crucible after pouring alloy out.

Incomplete union between the two, iron in patches on upper surface of bar.

No. 1
90 % Cu, 10 % Fe

Melted Cu and Fe in separate crucibles, then added one to ~~the~~ the other; mixed, and poured into mould –

No 2.
80 % Cu, 20 % Fe

Melted Fe in crucible, then added Cu in pieces; [illegible] and poured into mould –

The mass not homogeneous. The Fe distributed in spots throughout the bar – vide page 10

No. 3.
70 % Cu, 30 % Fe

Treated same as preceding

Shines well, Appears to be homogeneous

No. 8 20% Cu, 80% Fe

Exposed iron in crucible to heat of fire for two hours;—part melted surface of molten iron covered with a carbonaceous looking substance added copper in small pieces and reheated; a pasty mass, would not melt. Time iron was in fire from first, 3½ hours.

Melted Fe in crucible, then added Cu while crucible was in fire. Let crucible remain in fire sufficient time for the Fe & Cu to become thoroughly mixed, then just before pouring stirred well.

Treated the following all alike:

No. 1 90 % Cu, 10 % Fe
" 2 80 % Cu, 20 % Fe
" 4 60 % Cu, 40 % Fe
" 5 50 % Cu, 50 % Fe

" 7 30 % Cu, 70 % Fe
" 8 20 % Cu, 80 % Fe
" 9 10 % Cu, 90 % Fe

The alloys not homogeneous, separation of Fe and Cu, The Fe distributed in patches throughout the bar.

Copper and Lead

— "The alloys of copper and lead are difficult to obtain by the direct process in one fusion."

Frequet, 87

"Appears to be a mixture of two alloys, one containing more copper and fusing at a higher temperature, the other more lead and fusing at a lower temperature the latter flows out — when the metal is gently heated."

Gmelin V, 484

Melted Cu in crucible, and added Pb in small pieces; stirred well and poured into mould.

Treated the following all alike:

No. 1 90% Cu, 10% Pb

After polishing, appears to be homogeneous

No. 2 80% Cu, 20% Pb

Looks as though copper had "struck" to the surface.

After polishing, cloudy

No 2^{2} 66⅔% Cu 33½% Pb

Homogeneous

No. 3 70% Cu, 30% Pb

No. 4 60% Cu, 40% Pb.

Surface crystalline.

After polishing, mottled

No. 5 50% Cu, 50% Pb

Surface crystalline

After polishing, cloudy, showing spots

No. 6 40% Cu, 60% Pb.

Showing separation of Pb

No. 7 30% Cu, 70% Pb

Addition of Pb to molten Cu solidified Cu, placed in fire and reheated, two alloys seem to be formed – In the bar, plumbiferous copper; in the casting hole, cupriferous lead –

No. 8, 20 % Cu, 80 % Pb

Introduced Pb into molten Cu while in fire, let crucible remain a few minutes, then poured into mould –

No. 9 10 % Cu, 90 % Pb

Heated same as preceding

No. 8^2 20 % Cu, 80 % Pb

After mixing the two and allowing to cool, remelted – Perhaps not full proportion of Pb – Part may have volatilized –

Lead and Antimony

Melted Pb, then added Sb; reheated, stirred thoroughly, and poured -

Treated the following all alike

No. 1, 90% Pb, 10% Sb
" 2, 80% Pb, 20% Sb
" 3, 70% Pb, 30% Sb
" 4, 60% Pb, 40% Sb
" 5, 50% Pb, 50% Sb
" 6, 40% Pb, 60% Sb
" 7, 30% Pb, 70% Sb
" 8, 20% Pb, 80% Sb
" 9, 10% Pb, 90% Sb

Lead and Cadmium

Melted Pb, then added Cd; reheated, stirred, and poured. Tested the following alike

No. 1 90 % Pb, 10 % Cd
" 2 80 % Pb, 20 % Cd
" 3 70 % Pb, 30 % Cd
" 4 60 % Pb, 40 % Cd
" 5 50 % Pb, 50 % Cd
" 6 40 % Pb, 60 % Cd
" 7 30 % Pb, 70 % Cd

Copper & Antimony

Melted Cu in crucible, then added Sb in small pieces, and poured without reheating.

Treated Nos. 1, 2 & 3 alike

No. 1 90 % Cu, 10 % Sb
" 2. 80 % Cu, 20 % Sb
" 3 70 % Cu, 30 % Sb

Melted Cu in crucible, and introduced Sb while crucible was in fire; let it remain in fire until thoroughly mixed.

Treated the following all alike:

No. 4 60 % Cu, 40 % Sb
" 5 50 % Cu, 50 % Sb
" 6 40 % Cu, 60 % Sb
" 7 30 % Cu, 70 % Sb
" 8 20 % Cu, 80 % Sb
" 9 10 % Cu, 90 % Sb

Watts; vol, 1, 703.
Mentions but three alloys of Cd:-
100 pts Cu, 82.2 Cd
78.3 % Hg, 21.7 % Cd
100 pts Pt, 117.3 pts Cd
Fesquet, 152, but one, - Hg & Cd, an amalgam

Erase. This

Note page 48

Zinc and Cadmium

Very few alloys of Cd are known - Watts; 1,703; Fesquet, 152

Melted the Zn in crucible, then added Cd in small pieces; reheated and cast. Treated all of this series alike. -

No. 1, 90 % Zn, 10 % Cd
No. 2, 80 % Zn, 20 % Cd
" 3, 70 % Zn, 30 % Cd
" 4, 60 % Zn, 40 % Cd
" 5, 50 % Zn, 50 % Cd
" 6, 40 % Zn, 60 % Cd
" 7, 30 % Zn, 70 % Cd
" 8, 20 % Zn, 80 % Cd
" 9, 10 % Zn, 90 % Cd

Experienced no difficulty in effecting their combination -

Zinc and Antimony

"The alloys of antimony and zinc are but little known — They have presented but little interest to experimenters"

Guettier, 109

Melted Zn, then added Sb, and reheated — Treated the following alike =

No. 1, 90% Zn, 10% Sb
" 2, 80% Zn, 20% Sb
" 3, 70% Zn, 30% Sb
" 4, 60% Zn, 40% Sb
" 5, 50% Zn, 50% Sb
" 6, 40% Zn, 60% Sb
" 7, 30% Zn, 70% Sb
" 8, 20% Zn, 80% Sb
" 9, 10% Zn, 90% Sb

These alloys oxidize by heat very readily

By heating the CdS in graphite crucible decomposition took place — vapors being driven off, and a metallic, crystalline button left in crucible bottom.

Mixtures of the Sulphides, Arsenides,

PbS & CdS

PbS volatilizes at temperature lower than that necessary to fuse CdS. When heated in contact with the air it is decomposed.

Mixed the two, placed in crucible and exposed to white heat — complete volatilization; exposed to strong red heat, obtained a button. The temperature was not raised to that degree sufficient to fuse CdS, free from other substances, so that it may be unequally distributed throughout the PbS, held in suspension while the PbS was in a molten state.

Note page 52

No. 1
18 grams PbS, 2 grams CdS

" 2
16 " PbS, " CdS

" 3
14 " PbS, 6 " CdS

" 4
12 " PbS, 8 " CdS

These were smelted in graphite crucibles

No. 1 2 grams CdS
18 " PbS

" 2 4 grams CdS
16 " PbS

Mixture heated in luted hessian crucible to strong red heat –

No. 4

$$\left.\begin{array}{l}24 \text{ grams } Cu_2S \\ 15 \text{ '' } FeS\end{array}\right\} + S$$

Pulverized and mixed Cu_2S and FeS, placed in graphite crucible and exposed to white heat – then added 8 or 10 grams sulphur while crucible was in fire, and poured as quickly as possible – A ragged solid remained in bottom of crucible; examined it, appeared to be of same composition as that poured, fracture the same; placed in crucible and treated same as before – Same result, part remained in bottom of crucible – Placed the second pouring into crucible and treated as before –

A yellow, brittle button

Long [illegible]

No. 5

27 grains Cu_2S
15 " $Zn S$
2 " $Pb S$

Part of the button yellow, part grayish yellow.

No. 6

23 grains Cu
21 " Fe
3½ " S

Mixed the Cu and Fe, then placed in alternate layers in the crucible the sulphur and mixed metals. Luted cover on crucible, and exposed to white heat.

A large portion of the iron did not unite with the Cu_2S formed, but remained in crucible in the form of Fe S

J. Lawson

No. 7
28 grams Cu
7 " Fe
21 " S

Mixed, and fused at a white heat; one side of the button covered with metallic copper –

No. 8
23 grams Cu
21 " Fe
16 " S

Treated same as preceding. Globules scattered through the button, light yellow color, magnetic – Magnetic Sulphide!

No. 9
54 grams Fe
108 " As

Heated in covered crucible; obtained a button and a black powder

J. Lawson

No. 11

54 grams Copper
108 " Arsenic.

Fused Together in luted crucible
Dark grey crystalline button

No. 12 2.2 grams Ferrous Sulphide
1.5 " Metallic Copper

Fused Together in covered crucible
Dirty yellow button.

No. 13 Copper Arsenide
Iron " equal parts

Fused together in crucible
Do not mix well
~~Do not appear to mix well~~

No. 14 copper Arsenide
Sulphide equal parts
Fused together in crucible
Do not appear to mix well

J. Lawson

No. 15

75 grams Lead
30 " As

Melted Pb in crucible, then added As, slight loss by volatilization

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No. 16

38 grams Antimony
62 " Arsenic

Partially melted Sb, then introduced As – Great loss by volatilization.

No. 17

70 grams Bismuth
5 " Arsenic

Melted Bi, then added As

No. 18

34 grams Cadmium
24 " Arsenic

Melted Cd, then added As
Very brittle button, silvery lustre

No. 20
28 grams Feldspar.
20 " Cu_2S.

Fused together in hessian crucible –

No. 21 Same proportions as No. 12
$Fe\,S + Cu$

Exposed a longer time to heat

No. 22 Same as preceding –
Exposed to still stronger heat

No. 23
24 grams Fe
18 " S

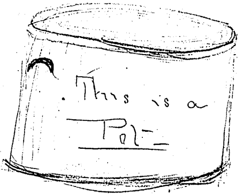
Exposed together to white heat nearly two hours –
Almost infusible in furnace –

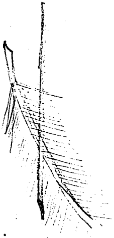
618d 4

19 grams Cuprous Sulphide
26 " Iron Sulphide (Magnetic)

Fused Together in crucible

Try alloy of Cu & Zn to which add a small quantity of nickel Phosphide –


This is a
Pot



$CuSO_4$

CuN

$Cu(NH_4)_2(SO_4)_2$

$CuSO_4 + 5H_2O$

63,5 32, 64 18

96 90

159,5

90

249.5

5)249,5

$(NH_4)_2SO_4$

14 32

4 64

18 96

2

36

96

132

64

2

2,0) 12,8

3) 6. 8/20

2 Dr.

Mar. 14 —

No. 1 Quite strong odor of H_2S.

Nos. 2 & 3 action going on solution colored blue (quite deep) ~~no~~ H_2S given off – [that is no odor]

No. 4 Energetic action a short time after being placed in solution H_2S evolved –

No. 5 – action not quite so energetic as No. 4.

Mch. 10 '80 – J. W. Lawson (C)

Some small pieces chalcopyrites from Ely Copper mines Vt. were placed in bottle and mixed with dilute ~~sol~~ ~~H_2~~ SO_4 – 5 % H_2SO_4. Placed in warm place.

2. Mch. 14. [Sp. gr. of acid 1.23]
Equal quantity coke to chalcopyrites in sulphuric acid placed in warm place –

3. Same as preceding placed in ordinary temperature –

4. Chalcopyrites & copper shavings in sulphuric acid placed in warm place –

5. Same as preceding but lead shavings instead of copper

6. Chalcopyrites, caustic soda, coke placed in warm place.
Caustic soda solution quite strong –

Mar. 22 -

7 - Bichromate potash, sulphuric acid, coke and chalcopyrites - placed in warm place

8 - Chloride ammonium and coke - placed in warm place - [5% H_2SO_4]

9 Manganese dioxide, coke, ~~ammonium chloride and~~ chalcopyrites equal quantities and a small amount of ammon. chloride -

Mar. 25 -

10 - Carbon, carbonate potash and chalcopyrites -

11 ditto with carb. ammon. -

12 ditto cyanide potassium

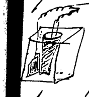
13- Same as No. 2 - ~~Cast being taken that~~ to see if the same reaction occurs as in No. 2 -

Fused chalcopyrite with metallic lead, part of the lead entered into combination with ~~the other~~ two sulphides forming an easily fusible sulphide; a bar of this was cast and used as an anode to try whether ~~the~~ copper could be removed from it by means of the electric current -

14. Same as No. 2 - acid more dilute 5% H_2SO_4

J.W. Lawson

Experiments with auriferous pyrites— April 13/80—



A glass jar was taken, in this was placed a porous cup; in the porous cup was placed the pyrites together with a ~~litt~~ small quantity of common salt; in the glass vessel and around the porous cup was packed common salt; two carbon plates were taken one placed in the porous cup in contact with the pyrites the other in the glass vessel in contact with the salt; wires leading from both plates were connected together at the ends; water was then added to both vessels

Powdered marble, coke and pyrites mixed together and placed in water

3 Sodium carbonate, coke and pyrites in water -

4 Calcium flouride, coke and pyrites in water -

5 Manganese dioxide, sodium chloride, coke and pyrites in water.

6 Pot: cyanide, coke and pyrites in water -

7 Caustic lime, coke and pyrites in water -

8 Bleaching powder and pyrites in water - { surface attacking of the pyrites

May. 11 1880

The bottom of a shallow vessel was covered with Hg. (impure) some powdered chalcopyrite was thrown on the surface of the Hg. a sheet of blotting paper placed over this and on the blotting paper was placed a clean sheet of carbon; very dilute sulphuric acid was then poured into the vessel until the carbon plate was covered with it; the carbon was then connected with a platinum wire dipping into the Hg and the vessel set aside for a few days -

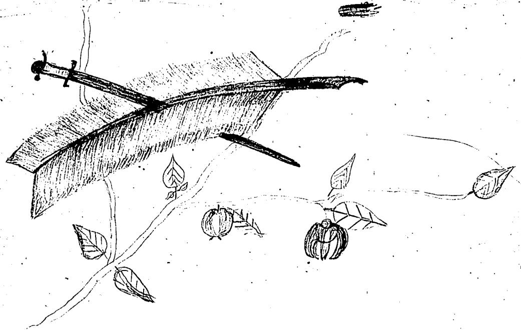
S	L
9	35
6	30
4.5	24
3	19
2.25	18

35
12
6
21)420(20
42
0

35
8
21)280(134
21
70
63
9.0

1/6

The pen is mightier than the sword



$Fe_2S_3 + 4HCl = 2FeCl_2 + H_2S + S$

$\left.\begin{matrix} FeS \\ FeS \end{matrix}\right\} S +$

450
80
24500

450
3
13.50

2200

200 grains

244

24
24
96
48
576

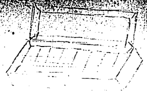
5.

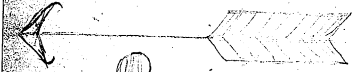
2000
5
450) 10.000 (244
900
1000
900
1000
900

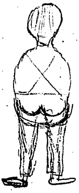
160
200
32,000

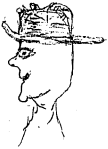
200 grains

16
2000
200) 32,000 (160
200
1200
1200
0000









5 Moulds perfectly dry before casting - Pulverized PbS and Cu_2S to ~~an~~ almost impalpable powder, mixed thoroughly, ~~[illegible]~~ melted at low temp., and cast

2 Dry moulds – Powdering PbS & Cu2S very fine, fuse at as low temperature as possible, and cast

3 Removed bad portions and remelted the double sulphide at lower temp. If any reduction of lead occurred allowed time for it to settle at bottom of crucible before running –

Deflection through 200 Ohms with armature up, 20° to 30°: internal resistance .5 to 1 Ohm

4 Heated moulds until perfectly dry – Removed bad portions from bars previously cast, remelted at as low temp. as possible, – low red heat –, and cast – Deflection through 200 Ohms, with armature up 30° to 50°; internal resistance .7 to 1.5 Ohms –

J.W. Lawson

Lead Sulphide & Cuprous

The fusing [illegible] lower than that of Cu_2S, which is the higher of the two

It expands on cooling, Cu_2S contracts —

Fracture uneven, crystalline dark grey -

Lawson

Lead Sulphide & Cuprous Sulphi

239 PbS + 159 Cu_2S -

Melted together in covered crucible.-

First bar cast gave deflection 20° to right - internal resistance .08 Ohm. Two bars cast at same time, each gave deflection of 20° to right, & internal resistance, one .14, the other .2 Ohm

Cast several bars, patches of metallic lead, or a lower sulphide formed in bars. Perhaps raised temp. too high -

Δ = Heat

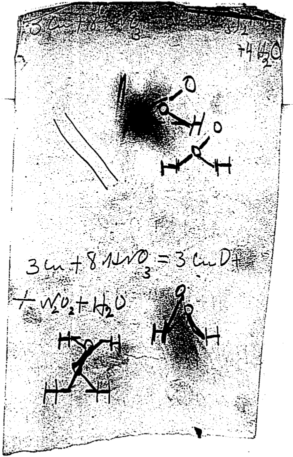
Bars cast with Cu_2S containing excess of S. Simply melted and run into moulds. Deflection 60° to 70° to left. Internal resistance of bars 18 to 19 Ohms.

SnS_2

Metal tin [illegible] + S, made into thick paste, placed in crucible, covered with NH_4Cl — Exposed to red heat — Result, amorphous sulphide? Placed in crucible with excess of S and covered with NH_4Cl Exposed to red heat.

Result — SnS_2 —

[ITEM FOUND IN BOOK]

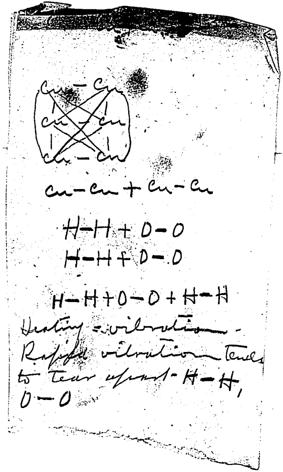


$3Cu + 8HNO_3$ [illegible] $(NO_3)_2$ [illegible] $+ 4H_2O$

$3Cu + 8HNO_3 = 3CuO +$

$+ N_2O_2 + H_2O$

[ITEM FOUND IN BOOK]



Cu — Cu
Cu — Cu
Cu — Cu

Cu — Cu + Cu — Cu

H — H + O — O
H — H + O — O

H — H + O — O + H — H

Heating = vibration -
Rapid vibration tends
to tear apart - H — H,
O — O

[ITEM FOUND IN BOOK]

will not now be as in the first case

If the group as it was originally apply the first force then the third next the second now remove the first and the positions of the mol. will not be as in the second case

Applying this to mind it is easy to see how the same impression or impressions will not give rise to the same thoughts in every case

a group of mol. a force is applied to one it produces a certain change. a force is applied to another it produces a different change.

Let the last force be removed and the mol. will re[illegible] the position they [illegible] under the first force

Let a third force be applied the first force removed and the second force applied = let the third force be removed and the first force applied the position of the molecules